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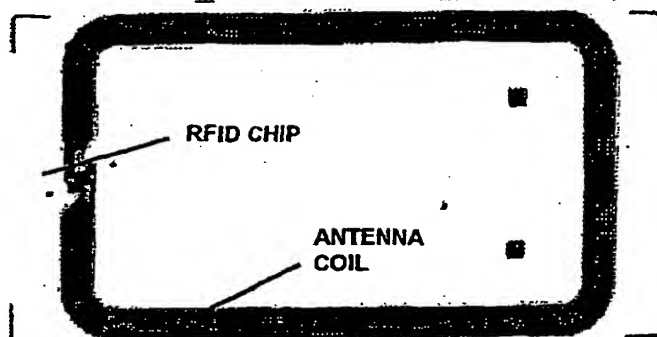
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(54) Title: METHOD FOR MANUFACTURING OF RFID INLET



(57) Abstract: A contact-less inlet and a method for the manufacture of such an inlet in mass volume production is described in this invention. The method involves steps of dispensing adhesive paste on the pads of the antenna coil, aligning the bumps on the chip with the corresponding pads, curing of the adhesive and henceforth making the inlet connected electrically. The invention can therefore be applied through large-scale production as the method described has cost and speed advantages.

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## METHOD FOR MANUFACTURING OF RFID INLET

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates to a method for the manufacturing of an inlet that carries an integrated circuit (hereinafter "IC") chip. The inlet serves as a radio frequency identification (hereinafter "RFID") device, where it collects the energy to operate from a RF field emitted by a reader device. Therefore the RFIDs are non-contact devices that do not need battery to operate. Such device is designed to perform various applications, ranging from everyday usage to new emerging opportunities. Some of these applications are Access Control, Airline Baggage, Animal & Object Identification, Car Immobilisation, Cash Card, Computer Security, Emergency Response, Home Surveillance, Laundry Tagging, Logistics, Parcel Services, Retailing, Ticketing, Traffic Tolls, Warehousing, Anti-Counterfeiting Measures, Asset Management, Close Circuit Cash-less Systems, Operations Tracking, Outpatient Care Techniques, Personal Autonomy, Personnel Monitoring, Prepayment Programs, Selective Access and Sports Performance Monitoring.

#### 2. Description of the Prior Art

Product tagging has long been a tradition in many trades and industries. The main purpose of tagging includes price listing, product description, country of origin, inventory control, anti-theft and many more other functions. Most of the current tagging methods could only include a few of these functions. However, more and more product information are required to be tagged on as the world progresses. Therefore, the concept of a RFID is conceived and becomes a reality, where most of the product tagging functions is included in one single tag.

A RFID label is a paper-thin identification label with a programmable IC inside and an antenna connected to it. It communicates through RF signals with a fixed-position or handheld reader/writer over some distances. A RFID label can store user data in the IC's memory, and therefore allows stored data to be modified without the need to replace the label. A RFID label usually consists of 3 layers, two of which is the top and bottom covers with an inlet in between. The covers allow printing while the inlet is the core layer of the RFID label. The inlet is where the circuit and IC are located, as shown in FIG. 1.

There are known ways of making interconnects between the IC and the circuit. The most popular method being, using a gold wire to bond on both the circuit and the IC. Wire Bonding technique is the oldest technology available in the semiconductor assembly. It is therefore very established and equipment is readily available for mass production. Wire Bonding could also offer low cost solution as its materials such as gold wire and encapsulant are heavily used in the semiconductor assembly. However, one of the major disadvantages of wire bonding technology is the creation of high stand-off. High profile means thicker assembly and larger area. It would be very difficult if not impossible, for inlets with high stand off to be printed. The manufacturing processes of this technology is also more involving, thus more process steps are required, FIG. 4.

Another popular method of interconnection is flip chip, either using polymer flip chip (FIG. 5.) or using anisotropic conductive (U.S. Patent 5,705,852)/non-conductive film (U.S. Patent 5,928,458). The main reason of using flip chip is to achieve a much lower profile than wire bonding. However, the major disadvantage of these flip chip methods is the high cost of manufacturing process of making polymer bumps (as in the former method) or the complexity of applying a film (as in the latter methods). These henceforth deter the widespread application for the mass production.

Other popular means of interconnecting method includes attaching a Chip Module onto the Antenna Circuitry (FIG. 6.). The Antenna Circuitry is normally etched on the plastic card. The interconnection between the Module and the Antenna Circuitry is then using Anisotropic Conductive Adhesive/Solder Ball/Solder Paste. However, the interconnection between the chip to the module circuitry is using a gold wire to bridge across. The module, where the chip is housed, by itself would not be able to function as a contact-free card. The complete product must consist of the Module and the Plastic Card (where Antenna Circuitry is).

The FR 2753819-A and DE 19709985-A are referring to the Chip Card, whereas this invention is about Chip on Flexible Substrate. Chip Card is typically rigid with a thickness of 760 $\mu$ m. However, the Flexible Substrate is typically of the thickness of 50~75 $\mu$ m.

## SUMMARY OF THE INVENTION

The present invention is aimed at proposing a method for the manufacturing of the non-contact RFID inlets that overcome the above-mentioned drawbacks, in order to produce in mass quantity. Thus, the current method would make the manufacturing of inlets more efficient and at lower cost.

The new method comprises the following steps in the order mentioned below:

- a. dispensing a sufficient amount of adhesive paste on the pads,
- b. aligning the bumps on the IC with the corresponding pads of the antenna coil,
- c. curing of the adhesive and therefore make the IC and pads connected electrically.

Thereby the bumps are electrically connected to the pads of the antenna coil with pressure and curing of the adhesive paste simultaneously. The antenna coils are stamped, etched, printed or by any other manufacturing methods that attached the antenna coil onto a substrate. The substrate material can be paper, PET, PVC, or any other plastic, or any materials that is flexible.

A contact-less card made as above is inserted into plastic card or pouch. An outdoor tag can be made whereby the inlet is molded in plastic or silicon.

This invention is achieved by, dispensing sufficient amount of adhesive paste onto the antenna coil, FIG. 11a, aligning the electrodes of the IC (or commonly known as bumps) with the electrodes of the antenna coil (or commonly known as pads), FIG. 11b, and curing of the adhesive, FIG. 11c.

The electrodes of the IC (FIG. 2) and antenna coil (FIG. 3) may electrically be connected to each other with pressure through direct attachment. Preferably, this method comprises a step of pressurizing the IC onto the antenna coil and curing of the adhesive paste simultaneously.

The advantages of this invention are utilisation of the most commonly available bumps (i.e. gold or nickel bumps, FIG. 10b & 10c) and the simplicity of dispensing the adhesive paste. This compared favourably with polymer flip chip whereby the bumps (FIG. 5b) are expensive and the paste is applied after the electrodes have connected. Thus the underfill material could only move slowly through capillary action under the polymer flip chip method. This invention is also better than the conductive/non-conductive film method (U.S. Patents 5,705,852 and 5,928,458) as the cost of adhesive paste is much lower than conductive/non-conductive film.

The new invention allows the advantage that the Flexible Substrate over could be easily fold over without failure, what is impossible with solutions according the discussed prior art..

Furthermore this invention is the method of direct interconnection between the Chip and the Antenna Circuitry (Figure 8). The means of interconnection would involve using adhesive paste as a mean to secure the chip bump to the antenna circuitry. Once the interconnection is completed, the end product could function as a contact-free inlet immediately. (Note: an inlet is less than 100 $\mu$ m thickness and it is flexible) On contrary, the module stated in the prior art is not an end product.

The interconnection methods between module circuitry-antenna circuitry (FIG. 7) and gold bump-antenna circuitry (FIG. 9) are also different. In the prior art, the connection between module circuitry and antenna circuitry is through a conductive medium (FIG. 7). The conductive medium could be conductive particles as found in anisotropic conductive adhesive or solder ball/paste pre-printed on the antenna circuitry. However, this invention is a direct chip attach method (FIG. 9) as the chip already has gold bumps (FIG. 10a) protruded as means of interconnection. The gold bumps (FIG. 10b) or nickel bumps (FIG. 10c) are part of the chip structure, where the bumps are chemically fused onto the chip pad to form part of the chip circuitry. This type of chip is generically known as flip chip.

Additional advantage of this invention is that it is suitable to apply onto antenna coils that are stamped, etched, printed or by any other manufacturing methods that attached the antenna coil onto a substrate that acts as a carrier. The substrate material can be paper, PET, PVC, or any other plastic, or any materials that is flexible in bending and in shape. Capitalising on the advantage of a flexible substrate, the completed inlet can then be inserted into a card as a contact-less card, or molded in plastic and silicon as an outdoor tag.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view showing the complete inlet in which consists of chip and antenna coil.

FIG. 2 is a typical view of a RFID chip with two I/O.

FIG. 3 is a view of a typical pattern of an antenna coil.

FIG. 4 is a view of a wire-bonded inlet.

FIG. 5a to 5b are views of polymer flip chip inlet with the details on the bump structure.

FIG. 6 to 7 are views of chip card interconnection details.

FIG. 8 to 9 are views of present invention corresponding to FIG. 1.

FIG. 10a to 10c are views showing bumps which typically made of gold and nickel.

FIG. 11a to 11c are views showing mounting steps according to the embodiment of the present invention.

**CLAIMS**

What is claimed:

1. A method for mounting a RFID chip onto the pads of an antenna coil. The method comprises the following steps in the order mentioned below:
  - a. dispensing a sufficient amount of adhesive paste on the pads,
  - b. aligning the bumps on the IC with the corresponding pads of the antenna coil,
  - c. curing of the adhesive and therefore make the IC and pads connected electrically.
2. A method for mounting a RFID chip according to Claim 1, wherein the bumps are electrically connected to the pads of the antenna coil with pressure and curing of the adhesive paste simultaneously.
3. A method for mounting according to Claim 1, with structure of Claim 2 whereby antenna coils are stamped, etched, printed or by any other manufacturing methods that attached the antenna coil onto a substrate. The substrate material can be paper, PET, PVC, or any other plastic, or any materials that is flexible.
4. A contact-less card whereby an inlet based on Claim 3 is inserted into plastic card or pouch.
5. An outdoor tag whereby the inlet based on Claim 3 is molded in plastic or silicon.

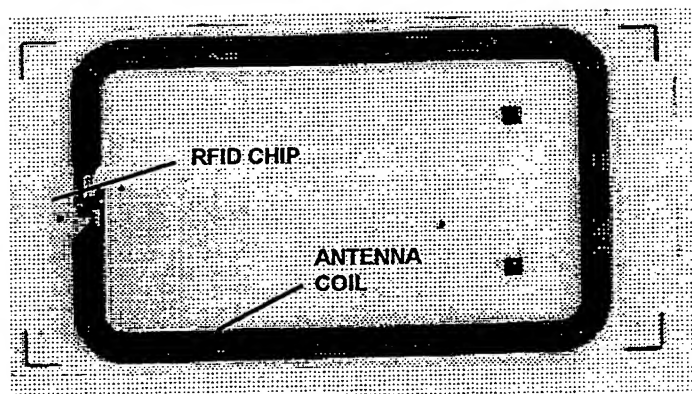


FIG. 1

FIG. 2

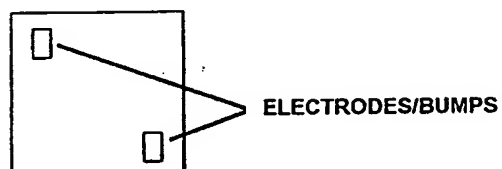


FIG. 3

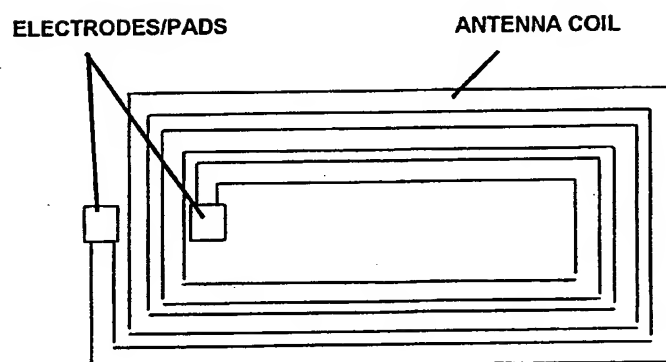


FIG. 4

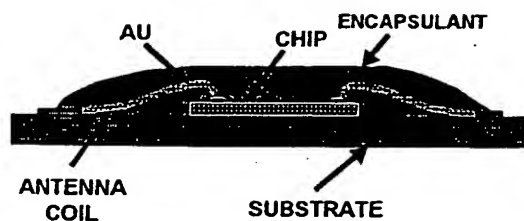


FIG. 5a

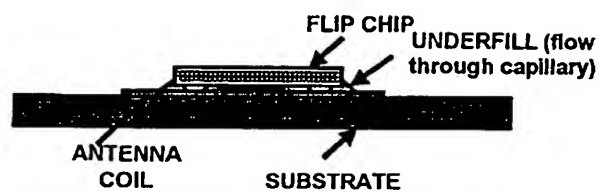


FIG. 5b

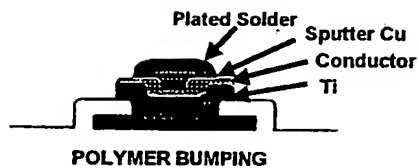


FIG. 6

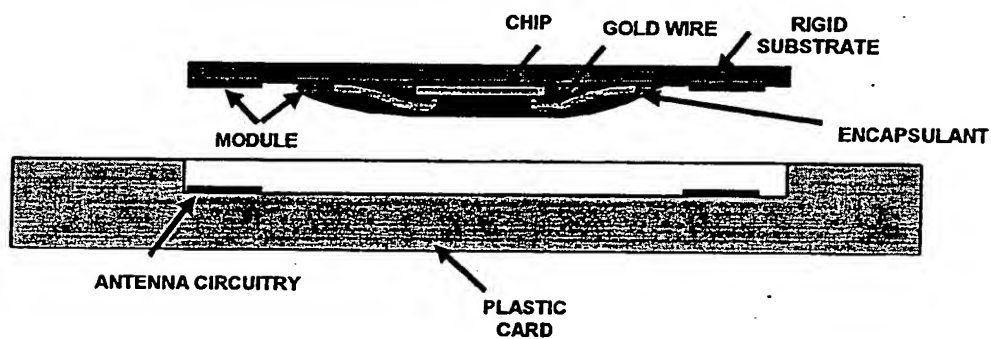


FIG. 7

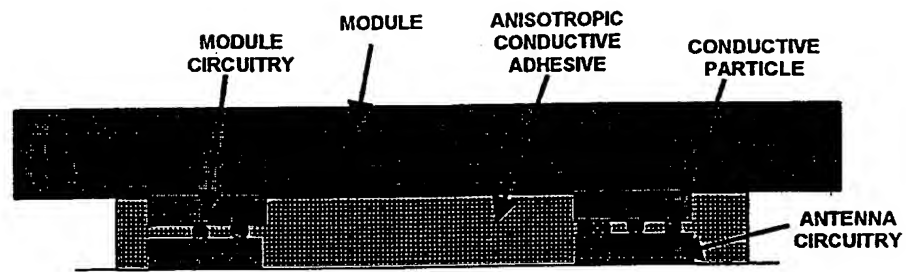


FIG. 8

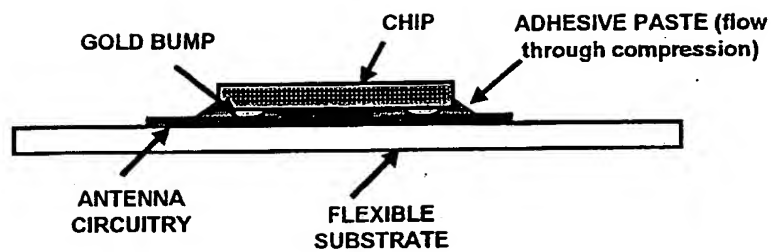


FIG. 9

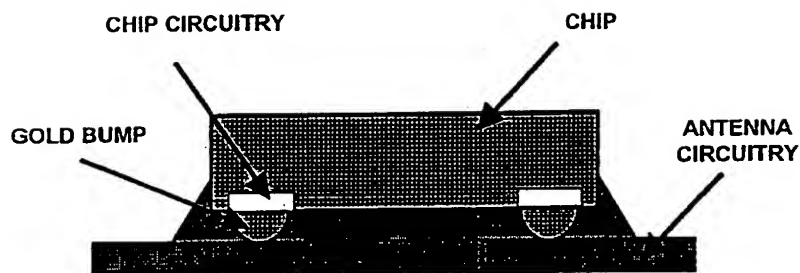
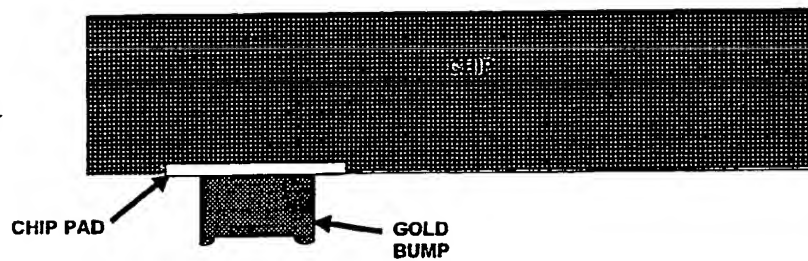


FIG. 10a



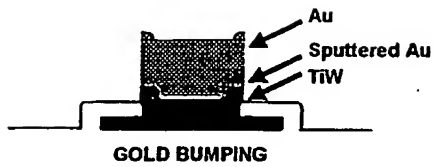


FIG. 10b



FIG. 10c

FIG. 11a



FIG. 11b

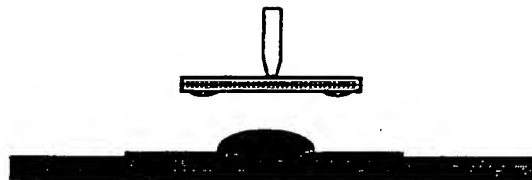
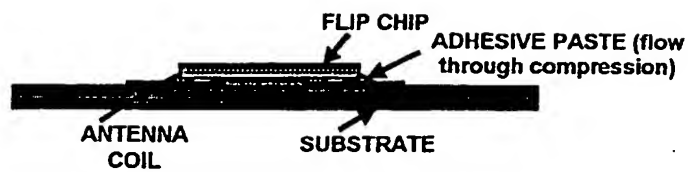


FIG. 11c



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